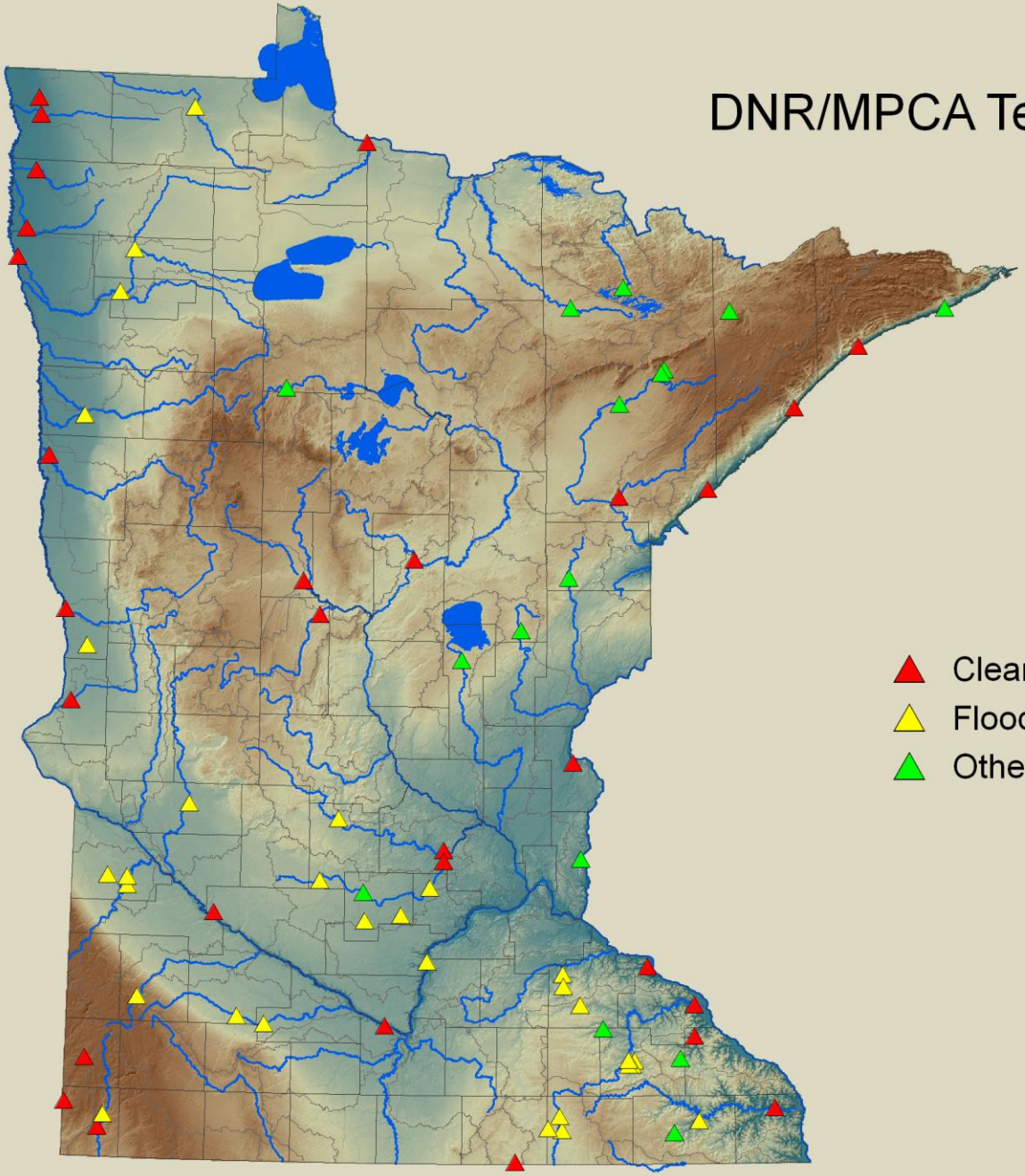
Surface Water Quantity Monitoring

BWSR Academy
October 26, 2011

DNR Ecological and Water Resources: Water Monitoring and Surveys Unit

- **Groundwater Monitoring**: 750 active monitoring wells
- **Lake Levels**: +1,100 lake gages and over 800 citizen monitors
- **Survey Crew**: Provides Topographic Surveys, OHW determinations and Vertical Control Elevations.
- **Climatology**: Stores and provides interpretation of data from over 1200 weather monitoring locations.
- **Stream Flow Monitoring**: +200 active stream gages

DNR/MPCA Telemetry Network



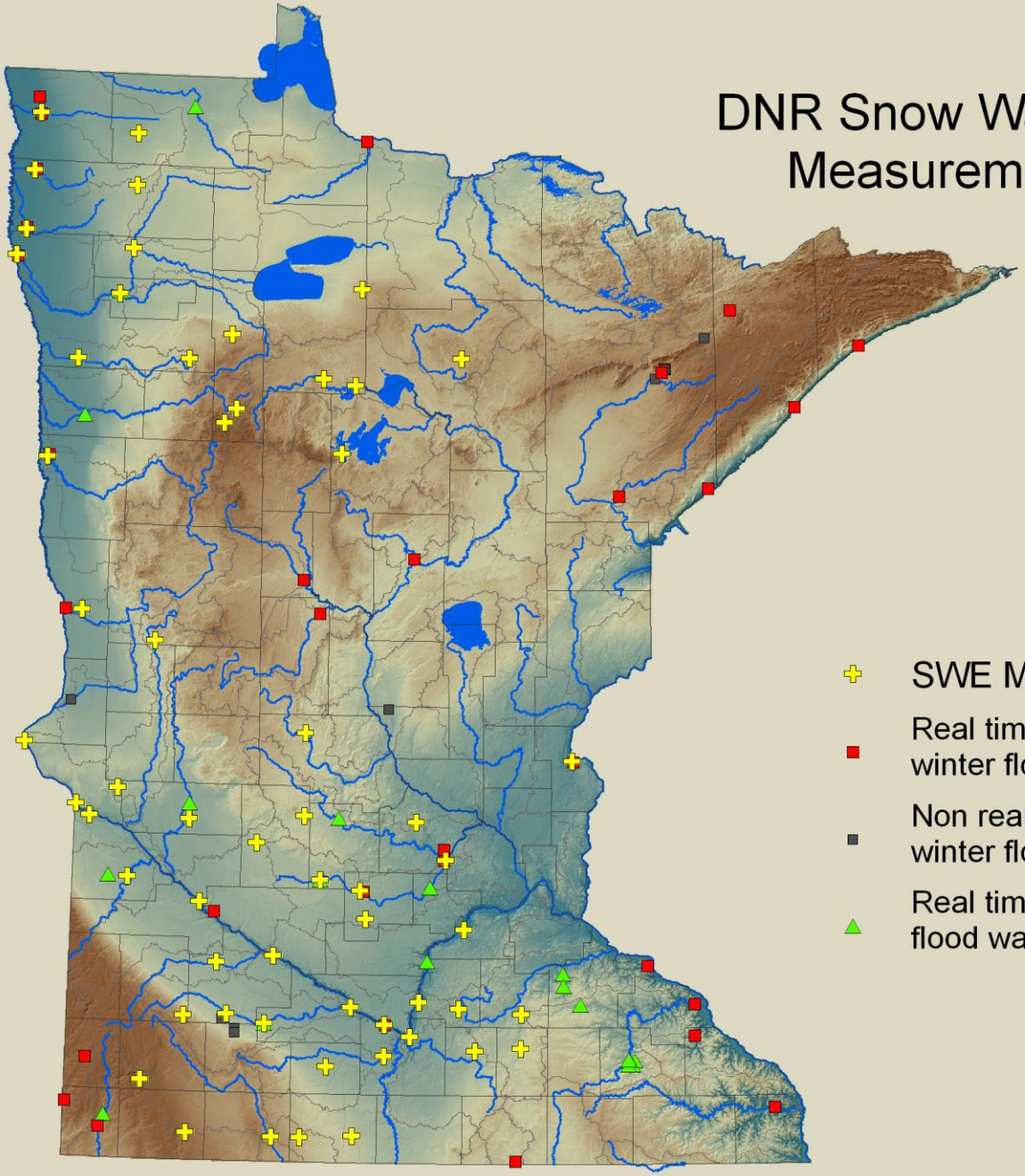
- Clean Water Legacy
- Flood Warning Gage
- Other monitoring network

Snow Depth and Water Equivalence

Taken by field crews and Area Hydrologists

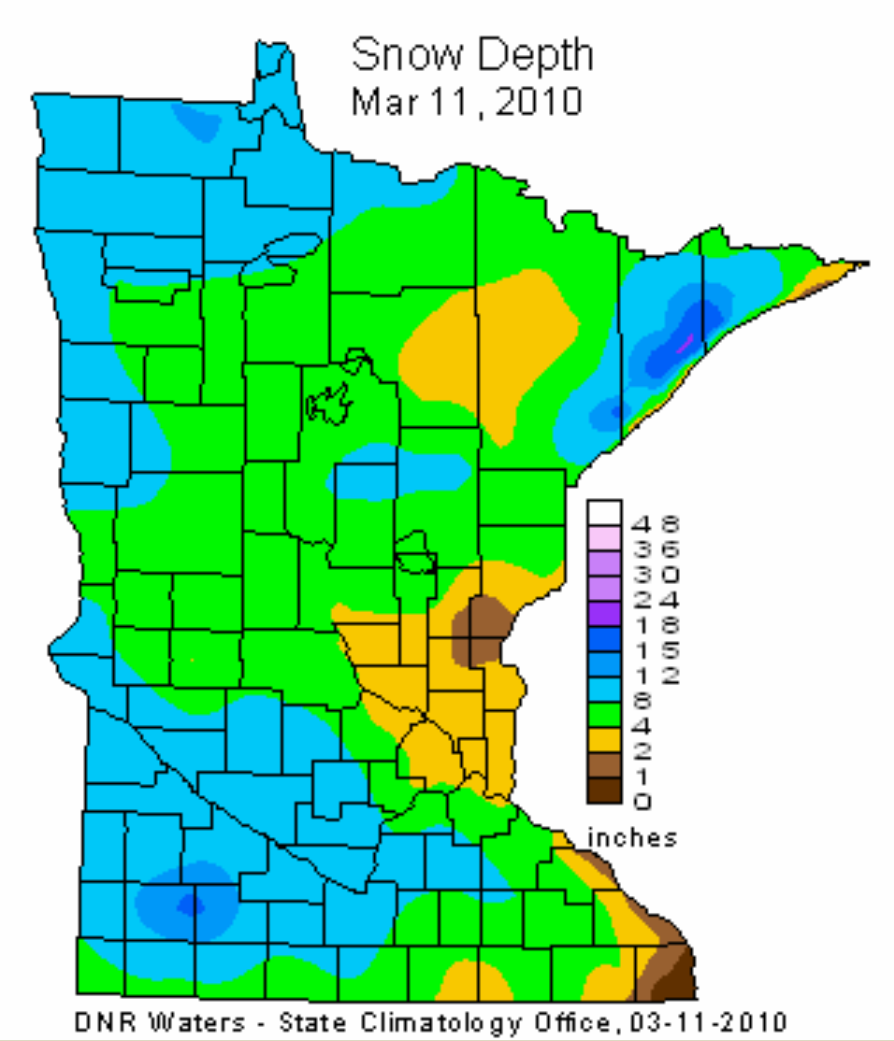
Sent to Climatology and National Weather Service River Forecast Center

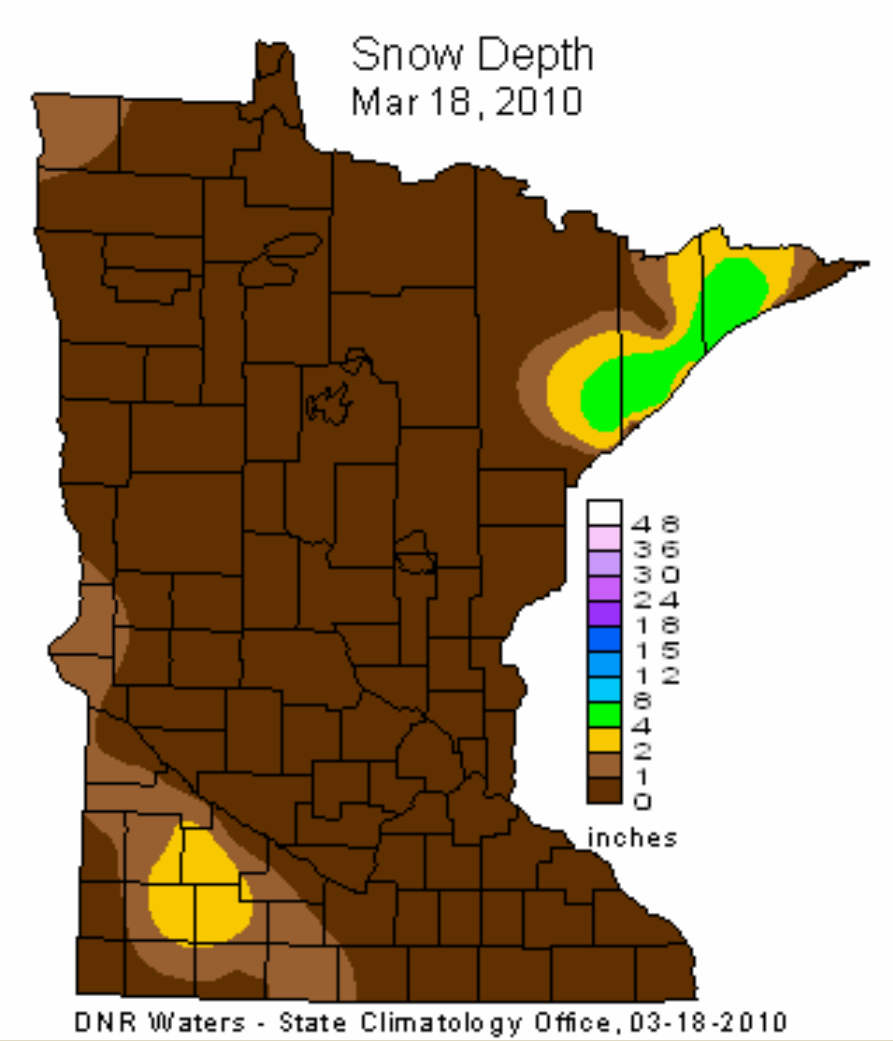
DNR Snow Water Equivalency Measurement Locations



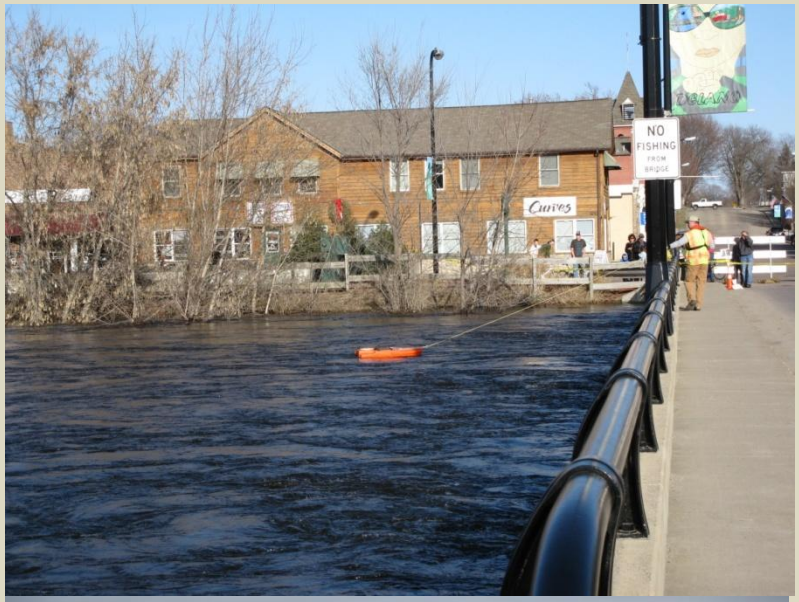
- SWE Measurement Locations
- Real time continuous gage - winter flow measurements (32)
- Non real time gage - winter flow measurements (8)
- Real time continuous gage - flood warning only (18)

One-Week Change in Snow Depth



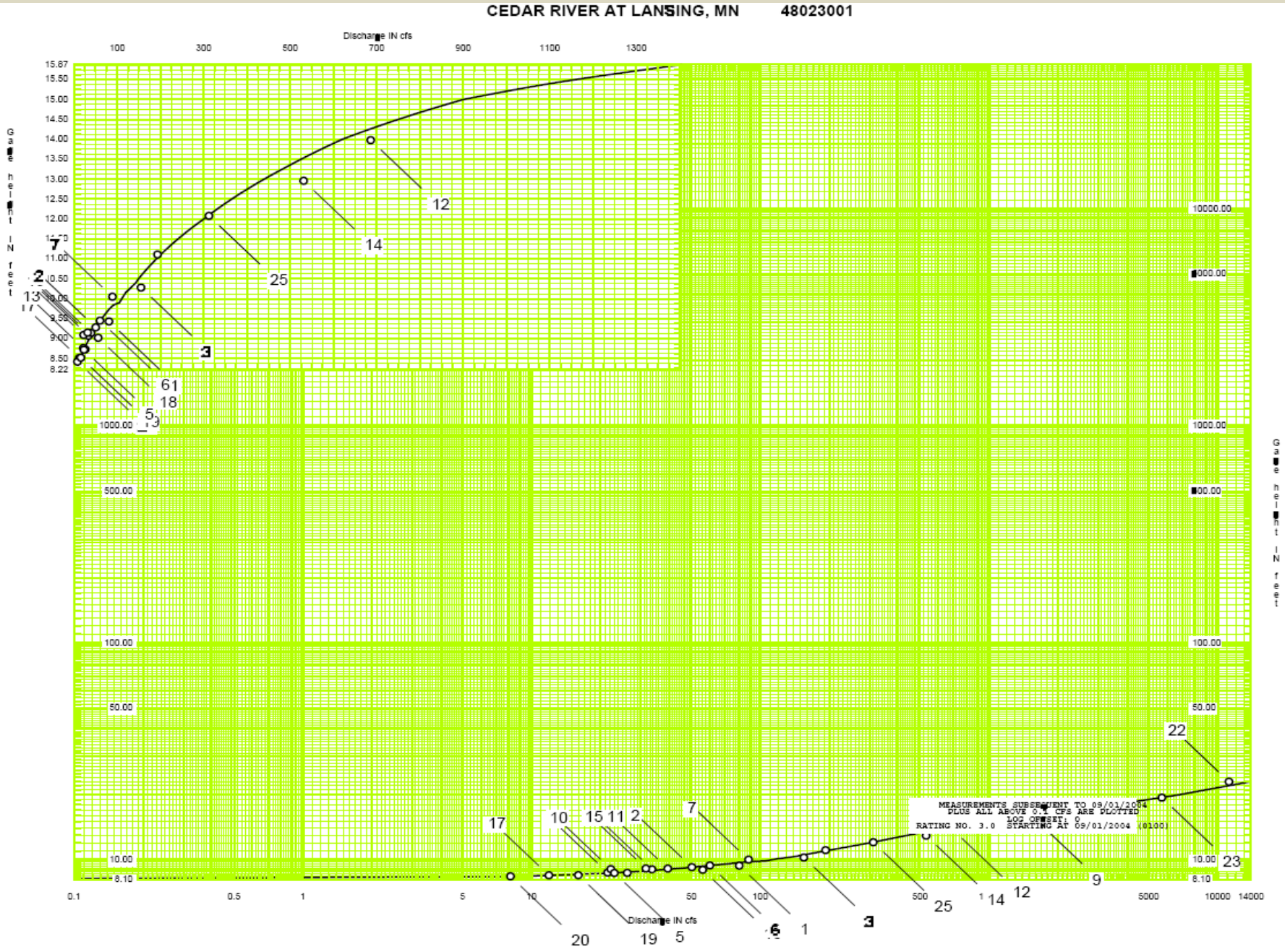


Prepared for this



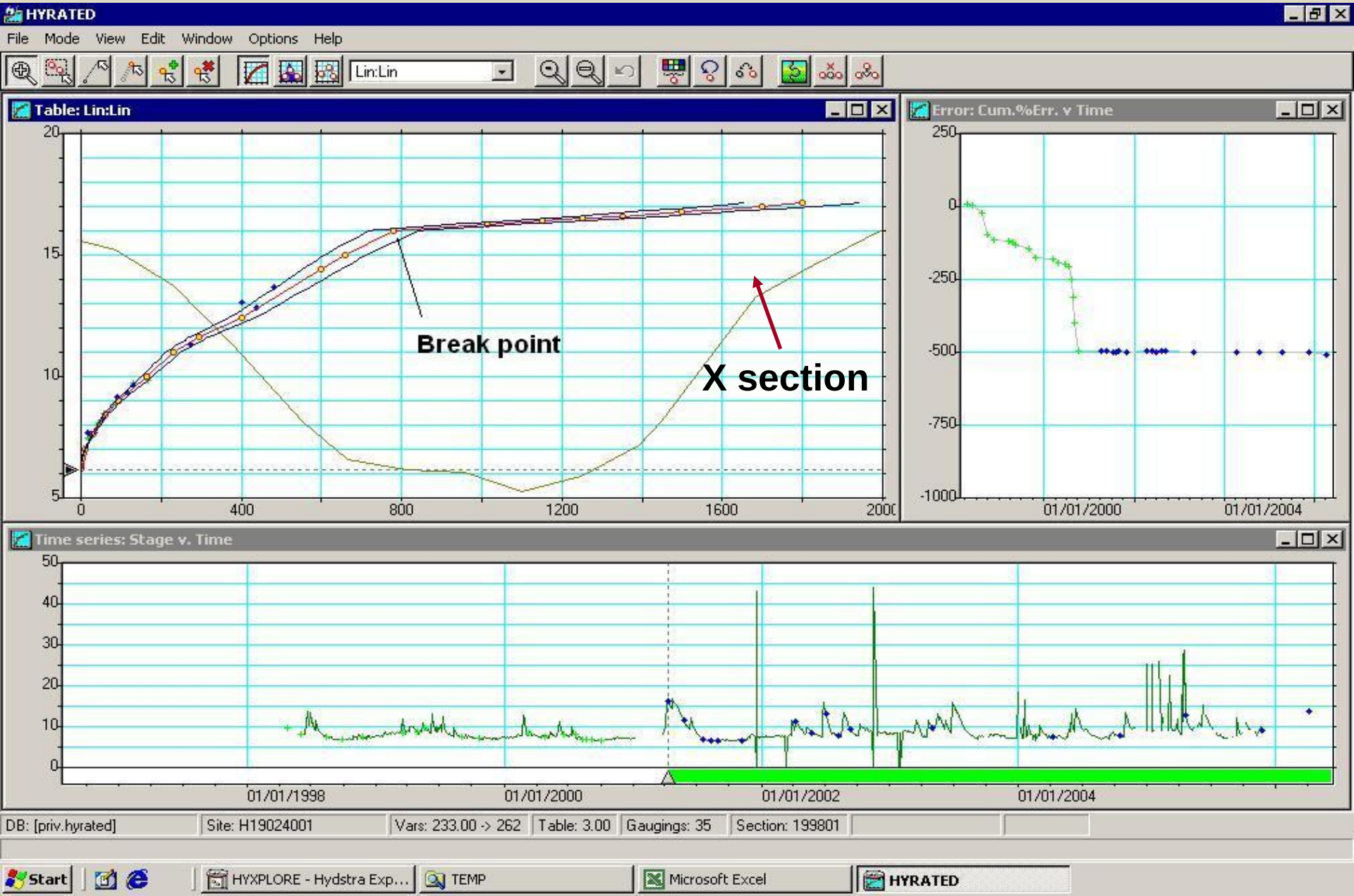
Stage – Discharge Relation

Rating Curve



Cross Sections

-available in Hyrated



Gage location should have a good "control"

- The control is the physical river characteristic(s) that influence the water flow and stage
- Two types of control: Section, Channel
- Section Control: Physical features at a cross section downstream of the gage site that constrict the flow or where a break in slope occurs in the river channel.
- Examples include: rock ledges, riffles, rapids, culverts, bridges. Most influence during low flows

Section Control

Channel Control

- Channel Control: Physical features of a long downstream reach of channel that controls the flow and stage.
- More common at lower gradient sites. Most influence during higher flow conditions.
- Most sites have section control at lower stages and channel control at higher stages.

Channel Control

Detailed Site Descriptions

- Provide specific details for a site for other users
- Provides recovery of site information for re establishment
- Repeatability and consistency in measurements
- Documents changes in site characteristics over time.

MINNESOTA DEPARTMENT OF NATURAL RESOURCES
WATERS

STREAM GAGE SITE DESCRIPTION

STATION NO. _____-_____-_____
RESOURCE NAME _____
@ / NEAR _____
Road Name / Number _____
Gage Phone # _____-_____-_____

DETAILED GAGE LOCATION:
Legal Description ____ ____ ____, Sec. ____, Tnp. _____, Rng. _____
Lat. _____ Long. _____ UTMX _____ UTMY_____
Quad. Map Name: _____
Quad. Map Number: _____
Count Name: _____
Additional Description:_____

DISCHARGE MEASUREMENT LOCATION:
Low Flow_____
High Flow_____

CONTROL DESCRIPTION:
Section Control (riffle, weir, rock ledge etc), Channel Control, Both

Description and Location(s):_____

PERMANENT BENCH, REFERENCE MARK AND MEASUREMENT POINT DESCRIPTION(S):

Whitewater River nr Beaver, CR 30
STATION ID: 40-016-001
USGS ID: 05376800
NWS ID: BVRM5

LOCATION:

Lat:	44° 09' 03" N	**UTMX:**	579571.0	**Township:**	Whitewater
Long:	92° 00' 18" W	**UTMY:**	4889107.1	**PLS:**	TWP 108, RNG 10W, SEC 15, Q SE, QQ SE

County: Winona
USGS Quad: V21a Beaver
Delorme MN Atlas & Gazetteer (pg): 35 (E8)

Driving directions: From intersection of US-61 and CR-74 near Weaver, travel west on CR-74 7.0 miles to intersection with CR-30. Travel east on CR-30 0.1 mile to bridge and gage.

History: Site established 8/17/06 as a Clean Water Legacy site. Present gage established by MN Department of Natural Resources, Waters Division on 6/3/08.
Drainage area (acres): 173,525

GAGE: Base gage is the lower bevel of a chiseled square on DS side of bridge, elevation of 711.60 ft. A Design Analysis H-350XL Pressure Transducer and H-355 Gas Purge System are housed in a 2' x 1.5' x 6' Hoffman look-in type shelter. Instruments are powered by a 1.2 ampere solar panel run to a deep cycle marine battery through a Sunsaver power regulator. Solar panel and a rain gage are attached to side of shelter on a 10' mast. Data collected at 15- minute intervals and transmitted via Goes satellite at 1-hour intervals.

Goes ID:	D55065D6
Primary Channel:	95E
Transmit Time (GMT):	005815
Random Channel:	119
Azimuth:	153
Elevation:	32

CHANNEL AND CONTROL:
Channel is controlled by rock riffle 50' DS of bridge

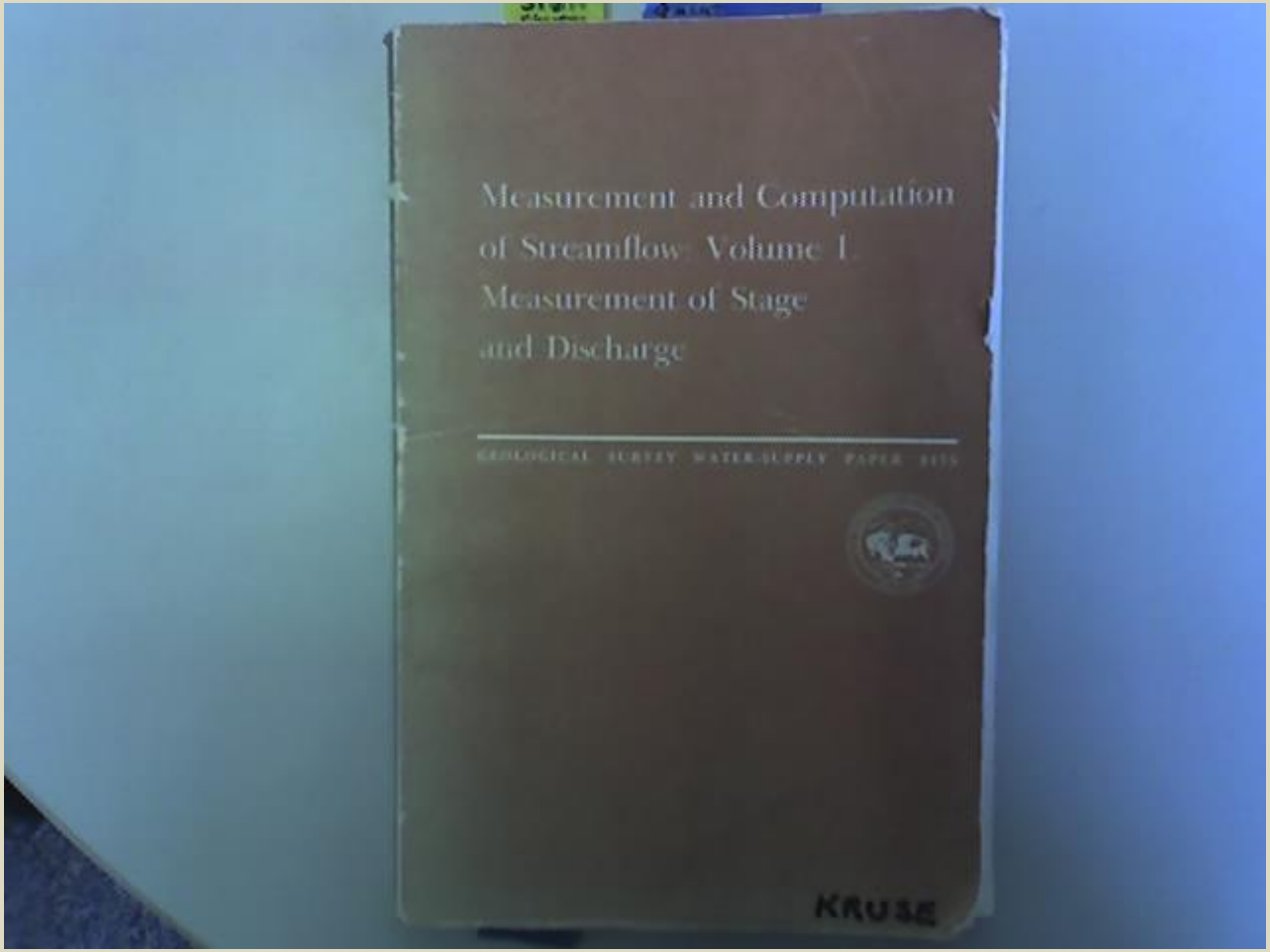
DISCHARGE MEASUREMENTS:
Low flow: Wading measurements can be made near canoe landing area
High flow: Higher stage measurements can be made from the downstream side of bridge.

Diversions: None
Cooperation: Minnesota Department of Natural Resources Division of Waters, Minnesota Pollution Control Agency, and National Weather Service.

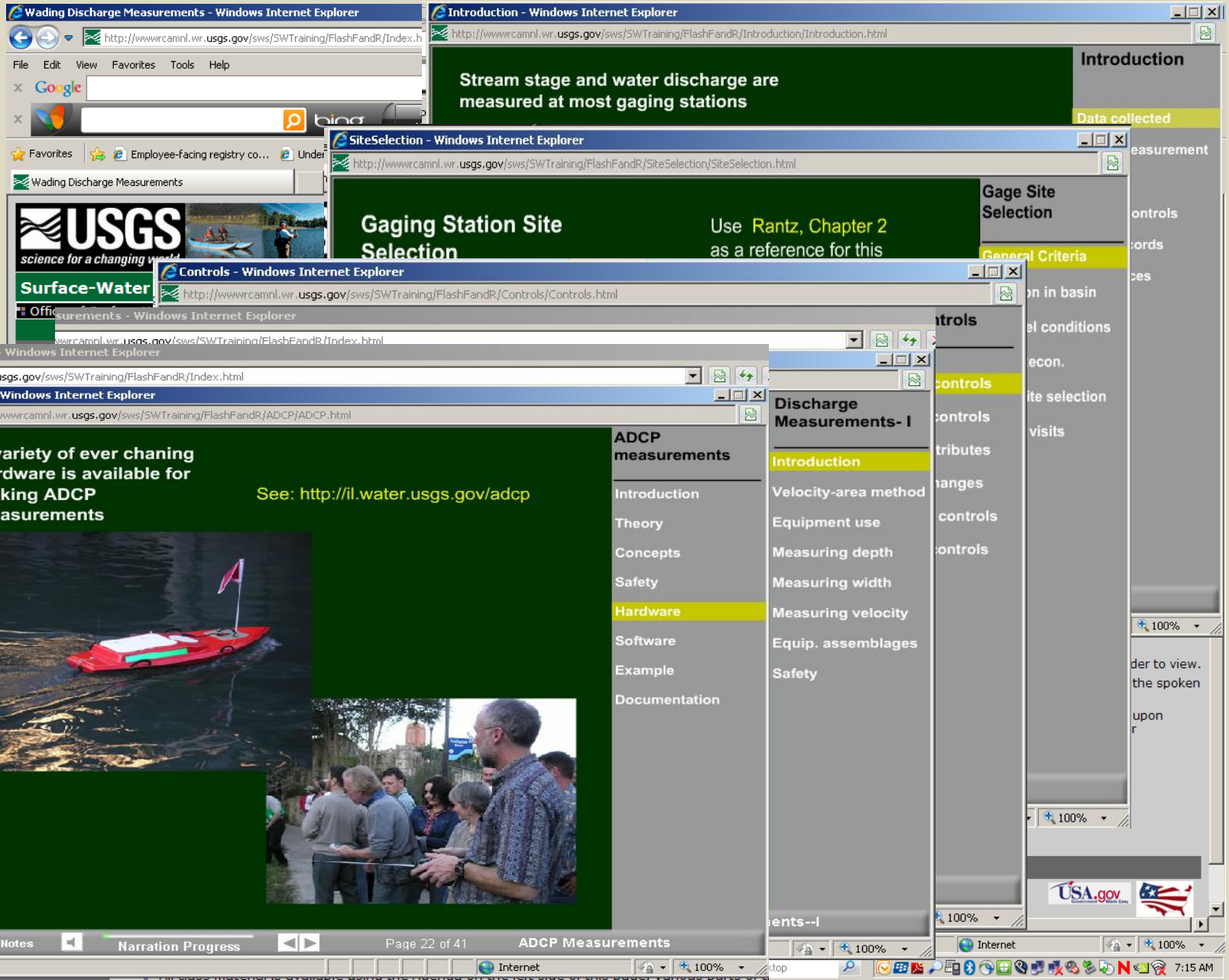
REFERENCE MARKS:
B.M. 1 **(BASE):** none
~~**Staff Gage (Destroyed 8/19/2007): Located 25' upstream of bridge in pool on left bank**~~
R.M. 1: Lowered beveled edge of chiseled square on upstream side of bridge, between 7th and 8th vertical support.
Inactive measure down, used 09/13/2006- 03/14/2008
Elevation: 111.55 ft gage datum (711.55 ft NGVD29)
R.M. 2 **(measure down established 03/14/2008):** Chiseled square on DS side of bridge, lower bevel, painted orange.
Elevation: 111.60 ft gage datum (711.60 ft NGVD29)

Primary reference: (RM2) 111.60 ft gage datum

Updated (10/07/08 alb)


Measurement and Computation
of Streamflow: Volume 1.
Measurement of Stage
and Discharge
KRUSE

http://wwwrcamnl.wr.usgs.gov/sws/SWTraining/FlashFandR/Index.html



Stream Flow and Velocity Measuring Equipment

DNR Water Monitoring and Surveys Unit follows USGS standards in the measurement and processing of stream flow data.

No oranges allowed.

V - Notch Weir

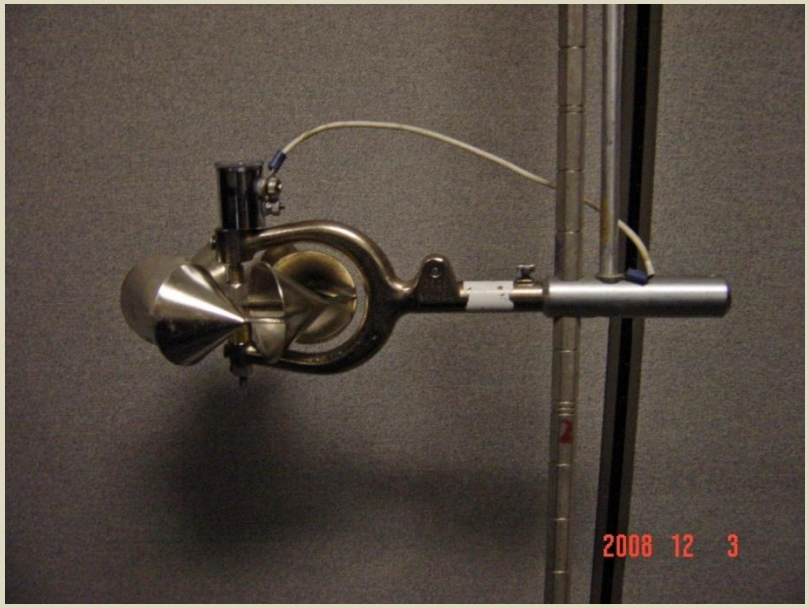
Parshall Flume

Price Mini (Pygmy) Current Meter

- Depth < 1.5 ft.
- Velocity 0.25 - 3.0 ft/sec.
- Spin Test 0.5 - 1.5 min.

Price AA Current Meter

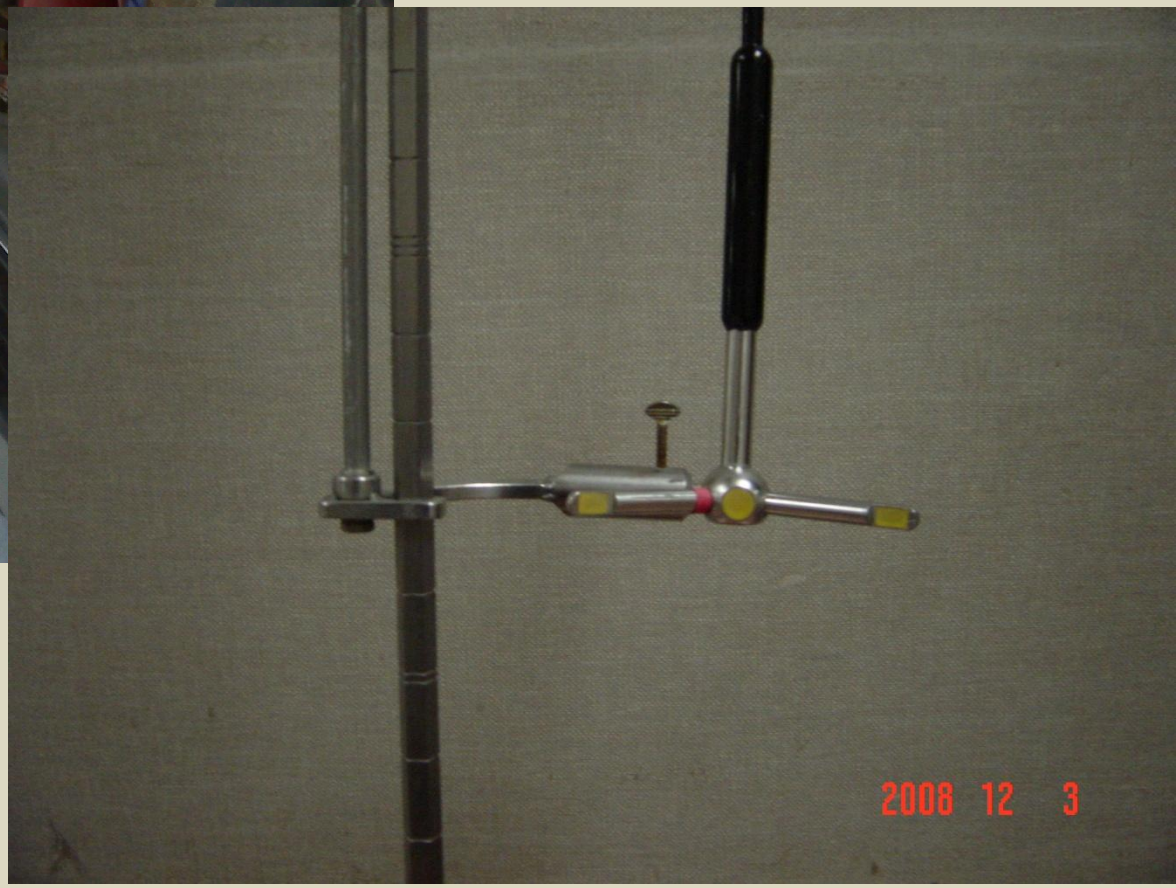
- Depth > 1.5 ft.
- Vel. 0.25 - 8.0 ft/sec
- Spin Test 1.5 - 4 min.



AquaCalc

Bridge Crane, Price Meter 100 lbs Sounding Weight

Flow Tracker AVM

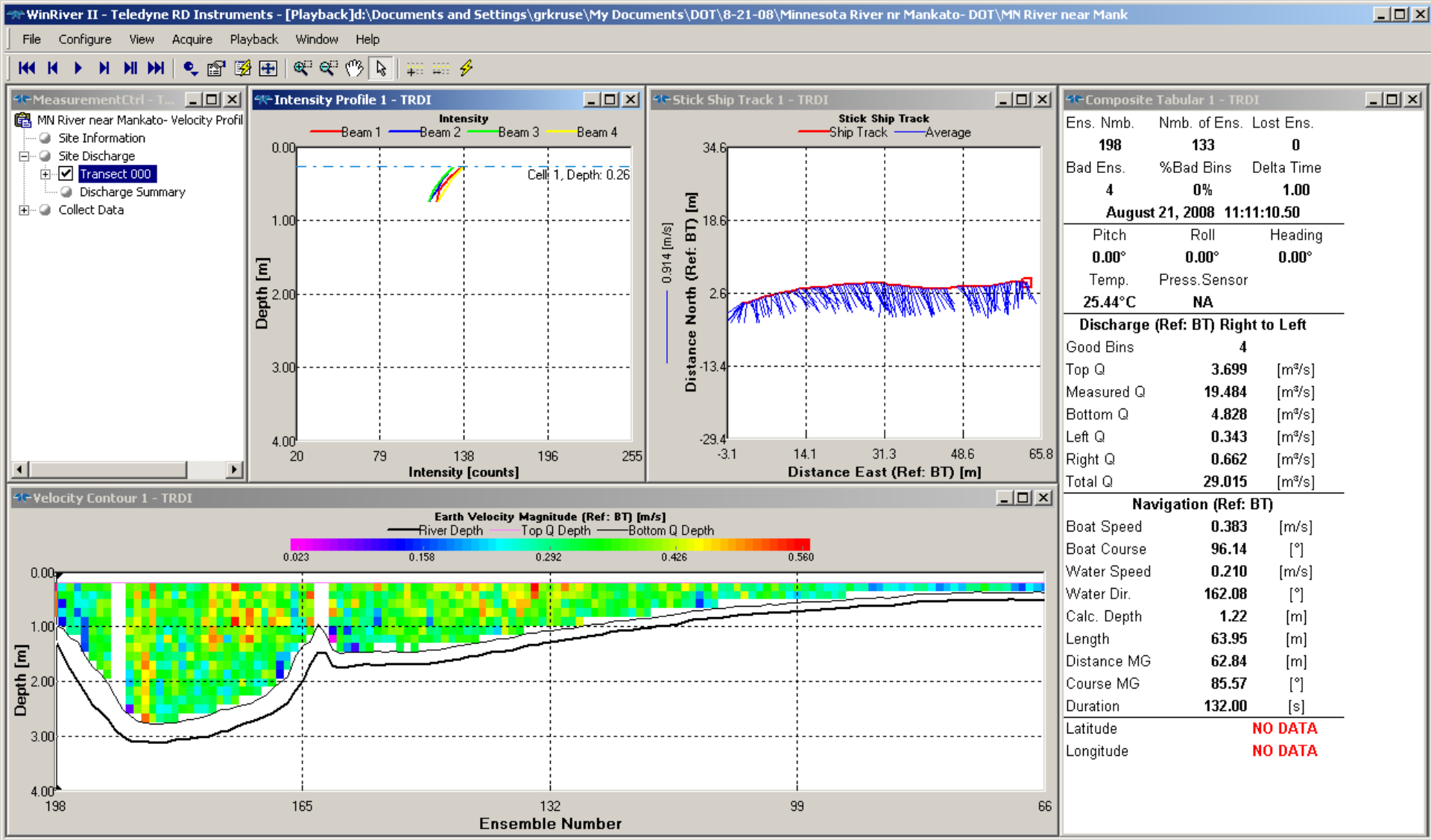


Acoustic Doppler Current Profiler

- Fast measurement time compared to traditional mechanical meters :15 – 30 min.
- Integrated Velocity Profile
- Depth range 2.5 ft to 50 ft.

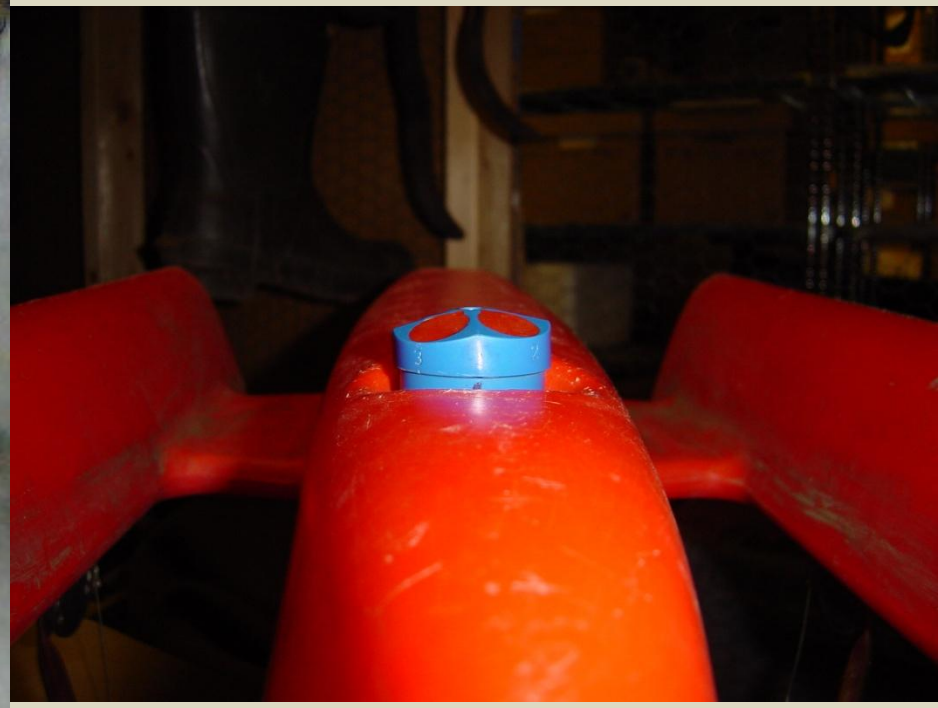
Bridge Deployment

Boat Deployment


WinRiver II - Teledyne RD Instruments - [Playback]d:\Documents and Settings\grkruse\My Documents\DOT\8-21-08\Minnesota River nr Mankato- DOT\MN River near Mank
File Configure View Acquire Playback Window Help
MeasurementCtrl - T...
MN River near Mankato- Velocity Profil
Site Information
Site Discharge
Transect 000
Discharge Summary
Collect Data
Intensity Profile 1 - TRDI
Intensity
Beam 1 Beam 2 Beam 3 Beam 4
Cell 1, Depth: 0.26
Depth [m]
Intensity [counts]
Stick Ship Track 1 - TRDI
Stick Ship Track
Ship Track Average
0.914 [m/s]
Distance North (Ref: BT) [m]
Distance East (Ref: BT) [m]
Composite Tabular 1 - TRDI
Ens. Nmb. Nmb. of Ens. Lost Ens.
198 133 0
Bad Ens. %Bad Bins Delta Time
4 0% 1.00
August 21, 2008 11:11:10.50
Pitch Roll Heading
0.00° 0.00° 0.00°
Temp. Press.Sensor
25.44°C NA
Discharge (Ref: BT) Right to Left
Good Bins 4
Top Q 3.699 [m³/s]
Measured Q 19.484 [m³/s]
Bottom Q 4.828 [m³/s]
Left Q 0.343 [m³/s]
Right Q 0.662 [m³/s]
Total Q 29.015 [m³/s]
Navigation (Ref: BT)
Boat Speed 0.383 [m/s]
Boat Course 96.14 [°]
Water Speed 0.210 [m/s]
Water Dir. 162.08 [°]
Calc. Depth 1.22 [m]
Length 63.95 [m]
Distance MG 62.84 [m]
Course MG 85.57 [°]
Duration 132.00 [s]
Latitude NO DATA
Longitude NO DATA
Velocity Contour 1 - TRDI
Earth Velocity Magnitude (Ref: BT) [m/s]
River Depth Top Q Depth Bottom Q Depth
Depth [m]
Ensemble Number
Start
BWSR2011.ppt [Compati...
WinRiver II - Teledyn...
Search Desktop
8:55 AM

Shallow Water ADCP

- Features similar to larger unit but less versatile
- Depth range 0.8 ft. to 16 ft.



Clean Water Legacy

Year Round Monitoring

- Ice measurements
- Ice thickness
- Snow depth and water equivalence

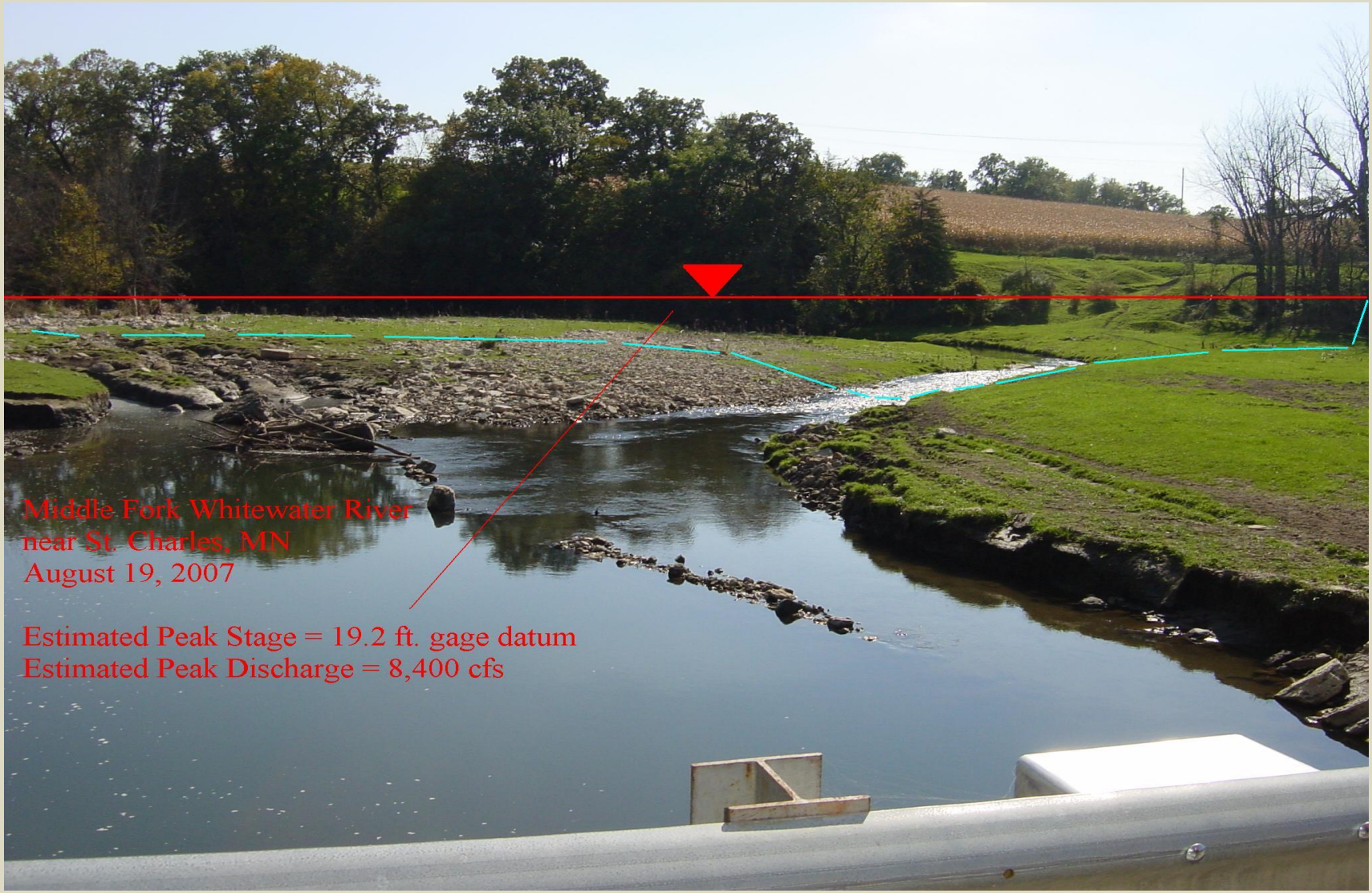
Shallow Water ADCP Measurement
Two Rivers @ Hallock

Wading Stream Flow Measurement

- Measuring and reporting accurate discharge is essential to understanding pollutant loadings, flood potential, channel forming events, and trend analyses.

Survey High Water Marks

Survey cross sections for modeling



High Water Mark Documentation

Roseau River @ Roseau

DNR Waters

High Water Mark Documentation

Wild Rice River nr. Ada

DNR Waters

Stage Sensors

- Staff gages
- Wire weight gages
- Submersible Pressure transducers
- Bubbler systems
- Sonic Sensors
- Radar Sensors
- Acoustic Velocity Meters

Standard Enamel Staff Gage

Bridge Mounted Wire Weight Gage

Bridge Mounted Sonic Sensor Gage

Bridge Mounted Radar Sensor Gage

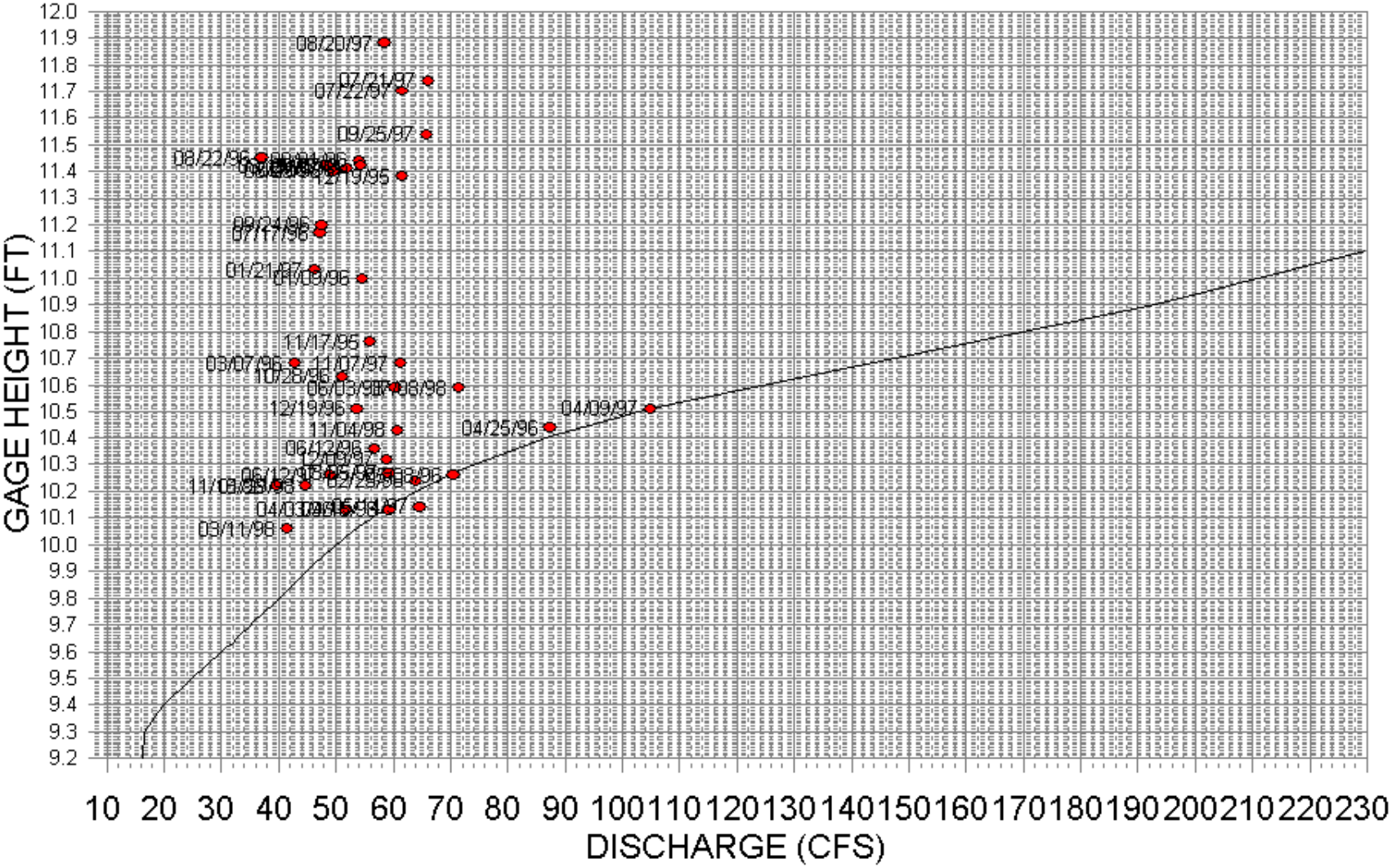
Acoustic Velocity Meters

Continuous Discharge Computation

- Define the rating curve with a minimum of 15 measurements throughout the range of flows
- Correct stage data from continuous recording equipment – drift correction
- Apply shifts to the rating for vegetation, debris, channel scour and deposition
- Apply the resulting relationship of discharge conditions to the stage data.
- Continue to make verification flow measurements throughout the life of a gage site

STRAIGHT RIVER
CR 115, WADENA CO.

(MDNR RATING #1)

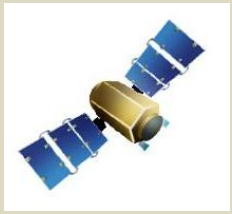


Clean Water Legacy

- Install permanent stream gages at the outlet of each of the 81 major watersheds
- Provide water quantity data for water quality, flooding and low flow frequency analyses and to monitor changes within the watersheds.
- Multiple use gages

Telemetry Gage Network

DCP Stream Gage



NOAA NESDIS

NWS HADS

NWS WFO

DNR/MPCA Cooperative Stream Gaging web site

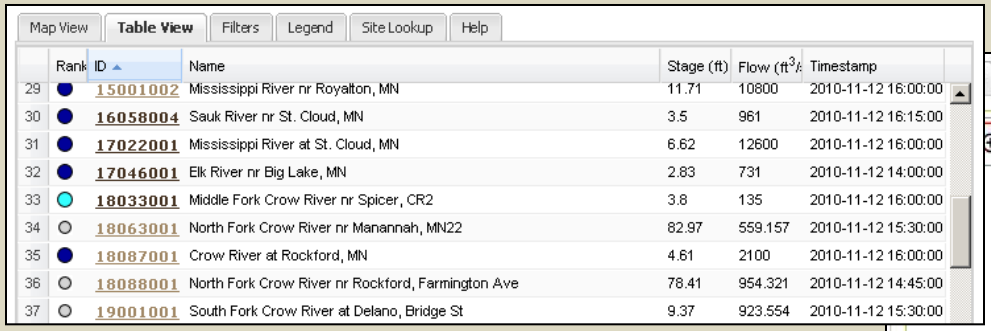
DNR FTP

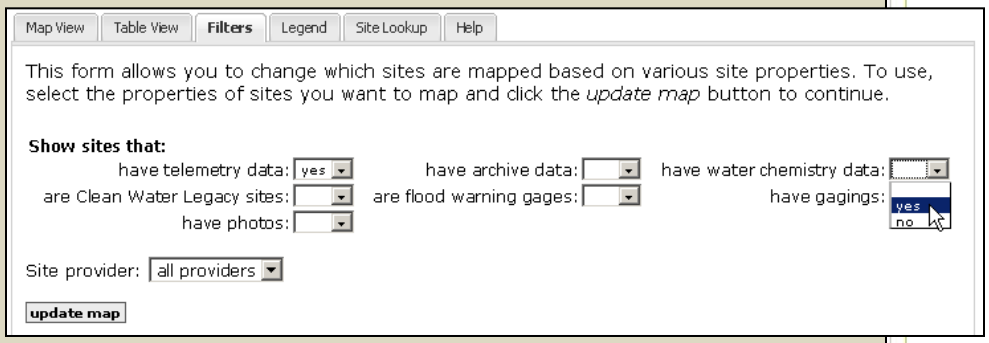
KISTERS

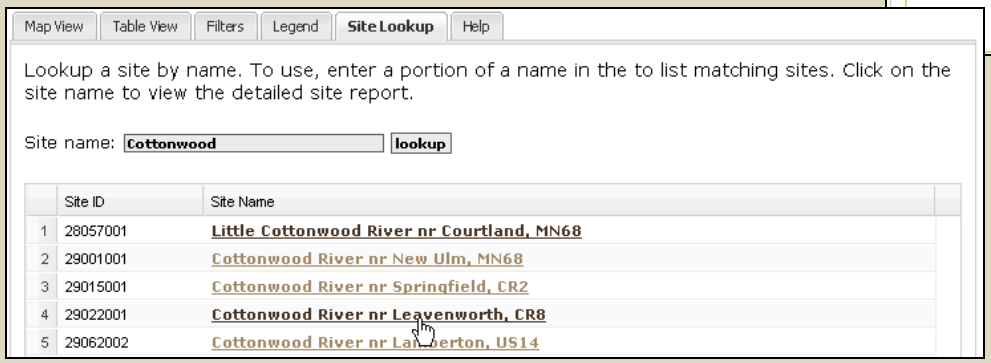
Hydstra Database

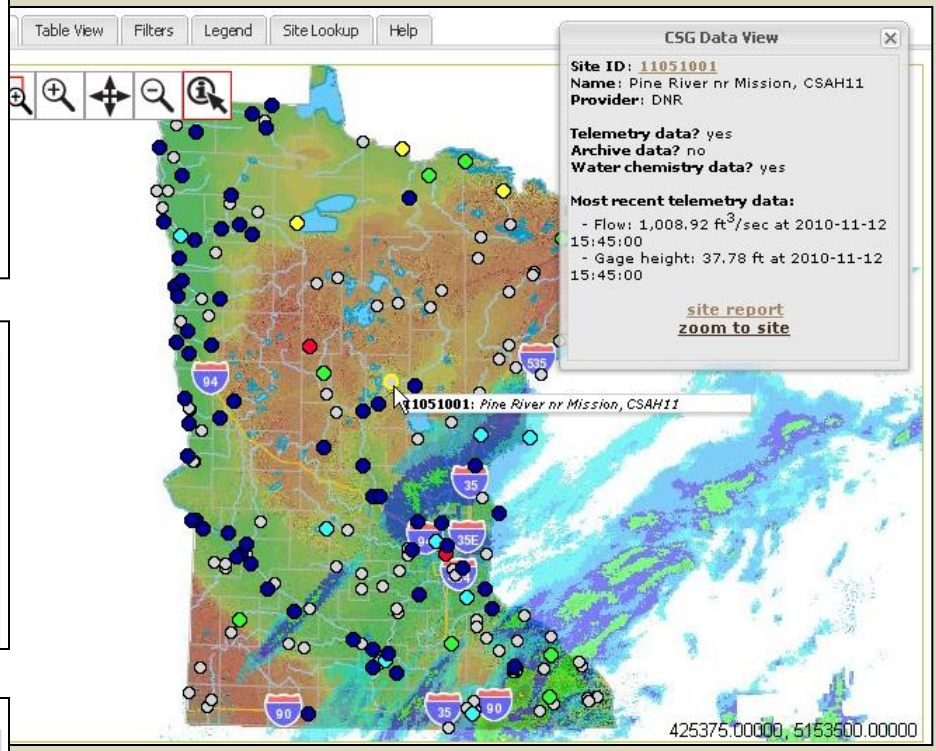
Minnesota Pollution Control Agency

Manipulate map or select gage









- Download gage location shapefile, georss, kml
- Customize map layers
- Customize gages shown on map
- Lakes on map link to DNR LakeFinder

Site Report

Site report

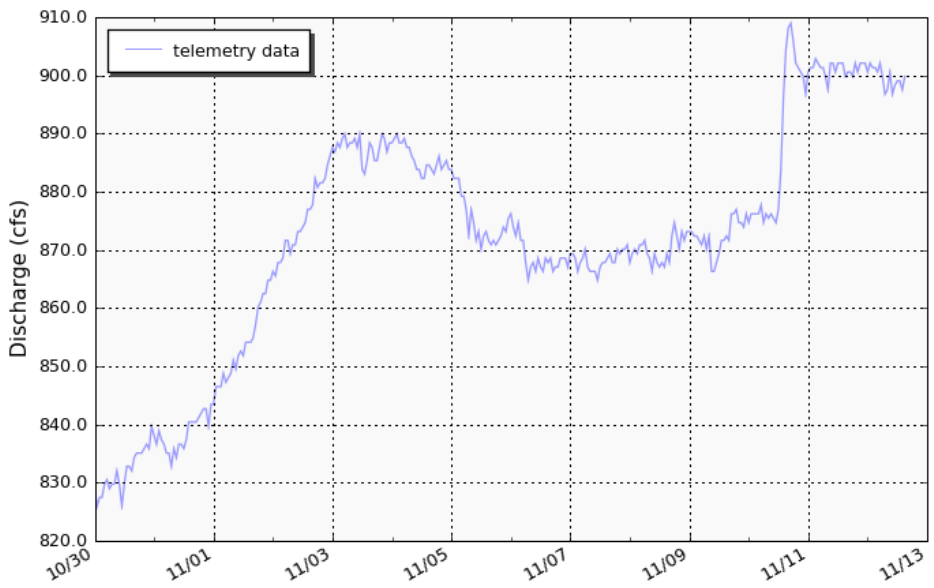
Summary

Site ID: 26037001 (*description*)
Name: Chippewa River at Benson, US12
Provider: DNR
USGS ID: 05303500
Lat/Lon: 45.311110, -95.624894

Most Recent Data
Stage: 9.65 ft at 2010-11-12 14:30:00
Flow: 896.762 ft^3/sec at 2010-11-12 14:30:00

Period of Record
Telemetry data: 2010-01-01 to 2010-11-12
Archive data: 1998-06-26 to 2006-11-09

Config Hydrograph | Hydrograph | Cross Section



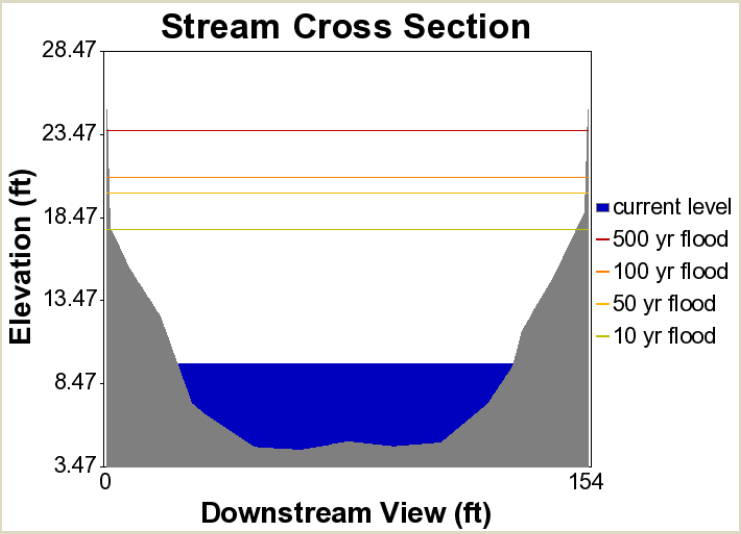
Download: all water chemistry data (csv) | water chemistry data for above period (csv)
all hydro data (csv) | data for above period (csv)
all year end summary data (html)

Config Hydrograph | Hydrograph | Cross Section

Variable
Raw Levels (ft)

Additional Data
- [x] show rainfall subplot
- [x] show gagings
- [ ] show photos

Dates
start: 2010-9-01
end: 2010-9-30



- Manipulate hydrograph
- Download data and year end summary narratives
- Download photos
- Plot gagings
- Links to USGS, AHPS, STORET

Low Cost Cooperative Local Water Quantity Monitoring Efforts

- Weirs or Dams with low cost stage recorders
- Snow water equivalent surveys
- Stage data verification measurements during sampling
- High water mark documentation
- Detailed notes during site visits

What's the best high tech monitoring tool available?

Collaboration and Resource Sharing

Provides cost effective, consistent data for multiple purposes

Cooperative Stream Gaging Program

A collaborative effort between Federal, State and Local Governments:

NWS, USGS, COE, DNR, PCA, Watershed Districts, CWPs,

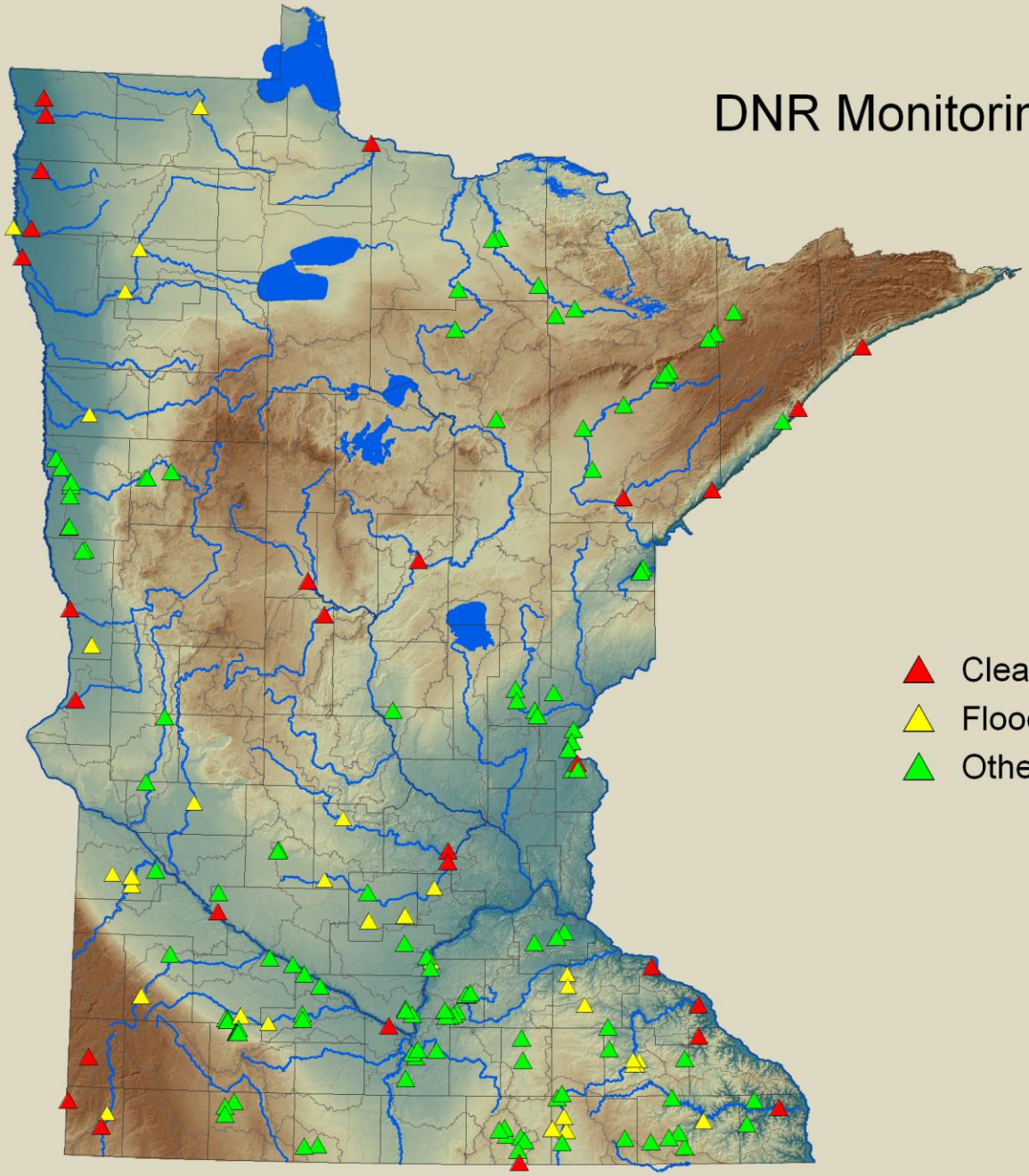
Counties, SWCDs and Cities

Minnesota Pollution Control Agency

NATIONAL WEATHER SERVICE

USGS science for a changing world

DNR Monitoring Gage Network



- Clean Water Legacy
- Flood Warning Gage
- Other monitoring network